PATENT SPECIFICATION

414,777

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PROVISIONAL SPECIFICATION.

Improvements in Synchronous Alternating Current Motors.

I, FRANK HOPE-JONES, M.I.E.E., F.R.A.S., of 32 & 34, Clerkenwell Road, in the County of London, Electrical Engineer, British Subject, do hereby declare the nature of this invention to be as follows:—

This invention has for its object improvements in small synchronous alternating current motors such as are customarily used for driving clock hands and the like.

It is usual in such motors, which are not self-starting, for a multi-polar rotor to revolve between a number of fixed poles and for the winding to be stationary and to form part of the stator assembly.

Such motors are conveniently divided into two classes, (1) those in which both magnetic elements are of soft iron and in which the propelling force is electro-magnetic attraction, (2) those in which one element is of soft iron and the other element consists of one or more permanent magnets, and in which the propelling force is attraction and repulsion.

In both the above types, the torque is poor because the magnetic impulse resulting from each half-cycle of the supply endeavours to move the rotor a distance equivalent to the whole space between two adjacent poles of the stator which are of opposite polarity. Further, the desire to reduce the space between adjacent poles of opposite polarity results in the stator often being in itself almost a continuously closed magnetic circuit, or at best a very leaky magnetic circuit, so that only part of the flux generated is available to act on the rotor.

This my invention concerns motors of class (2), in which the magnetic impulse resulting from each half-cycle of the electric supply endeavours to move a rotor a distance equivalent to only half the space between two adjacent poles.

An essential and original feature of this invention is a polarised element of cylindrical form, magnetised axially so that opposite ends of the cylinder are permanently North and South respectively, arranged adjacently to another cylindrical element whose ends fluctuate in polarity as a result of the passage of alternating current through a coil of wire.

In one method of carrying this my invention into effect, I may arrange an internal or central member as a bobbin of soft iron, so that the passage of an alternating current round a coil wound between the bobbin cheeks produces an alternating flux in the bobbin core, which causes the bobbin cheeks to fluctuate in polarity from north to south with the periodicity of the current, so that if teeth or poles are formed around the edges of these cheeks adjacent poles would always be of the same polarity. If this central member is mounted within an external member formed of two internally toothed and oppositely polarised rings, so that the two members can rotate relatively to one another about their common axis, the relative movement of the two parts is equivalent to one tooth space distance per A.C. cycle.

It is immaterial so far as the efficiency of the motor is concerned which of the two members remains fixed and which rotates, but as the rotation of the external member is inconvenient from a constructional point of view, I prefer that the internal member shall rotate, and in order to obviate the necessity of feeding current to a rotating winding, I may arrange for the winding to be completely clear of the bobbin so that it may be fixed and the bobbin left free to rotate. In other forms of this invention, the rotating element may be the one which is polarised in which case the coil through which the alternating current passes and its iron bobbin or core may both be fixed.

An advantage of this invention is that a motor having the same number of polar extremities as in the conventional type of motor has an effective speed of half that of the latter. Thus for a given torque, the physical dimensions of a motor constructed in accordance with this my invention may be appreciably reduced, which would result in economy of manufacture.

A result of the construction as described is that if there are say 50 poles on each cheek of the rotor, and say 50 opposite poles on each side of the stator, a propelling force will be exercised at 100 points

equally spaced all round the periphery of the motor, resulting in increased torque with efficiency and smooth balanced running, and economy in current consumption.

If the motor as described is supplied with alternating current at a frequency of 50 cycles per second, the rotor will revolve at a speed of one revolution per second, which is a very convenient speed for the operation of clock hands.

Mechanical difficulties in securing radial alignment of the rotor are lessened, which tends towards silent operation.

Dated the 15th day of February, 1933.

FRANK HOPE-JONES.

COMPLETE SPECIFICATION.

Improvements in Synchronous Alternating Current Motors.

I, FRANK HOPE-JONES, M.I.E.E., F.R.A.S., of 32 & 34, Clerkenwell Road, in the County of London, Electrical Engineer, British Subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention has for its object improvements in small synchronous alternating current motors such as are customarily used for driving clock hands and the like.

It is usual in such motors, which are not self-starting, for a multi-polar rotor to revolve between a number of fixed poles and for the winding to be stationary and to form part of the stator assembly.

Such motors are conveniently divided into two classes, (1) those in which both magnetic elements are of soft iron and in which the propelling force is electro-magnetic attraction, (2) those in which one element is of soft iron and the other element consists of one or more permanent magnets, and in which the propelling force is attraction and repulsion.

In type (1) the magnetic impulse resulting from each half-cycle of the supply endeavours to move the rotor a distance equivalent to the whole space between two adjacent poles of the stator.

This my invention concerns motors of class (2), in which the magnetic impulse resulting from each half-cycle of the electric supply endeavours to move a rotor a distance equivalent to only half the space between two adjacent poles.

An essential and original feature of this invention is a stator or rotor of cylindrical form magnetised axially so that opposite ends of the cylinder are permanently North and South respectively, arranged with its axis parallel to the rotor axis and adjacently to another cylindrical magnetic element whose ends fluctuate in polarity as a result of the passage of alternating current through a stationary coil of wire.

In one method of carrying this my invention into effect I arrange an internal or central member as a bobbin of soft iron or other high permeability material so that the passage of an alternating current through a coil wound between the bobbin cheeks produces a magnetic flux in the bobbin core whose cheeks fluctuate in polarity from North to South with the periodicity of the applied current. Teeth or poles are formed around the edges of the cheeks adjacent poles being always of the same polarity. If the central member is mounted within an external member formed of two internally toothed and polarised rings so that the two members can rotate relatively to one another about their common axis the relative movement of the two parts is equivalent to one tooth space distance per alternating current cycle.

This invention is described with the assistance of two sheets of explanatory drawings in which like parts are given the same reference letters.

Fig. 1 is a sectional plan of the motor through the plane of the axis of the rotor the stator being cylindrical and polarised in the direction of the axis.

Figs. 2 and 2A are sectional side and end elevations of an alternative construction of the same in which the stator is built up of a number of bar magnets arranged in cylindrical formation.

Fig. 3 is a sectional plan of a motor with the stator formed of a number of horse-shoe magnets arranged in cylindrical formation.

Fig. 4 illustrates in plan that form of the invention in which the rotor consists of permanent bar magnets and the stator is not permanently magnetised both members being cylindrical in form.

Fig. 5 illustrates the same but with the rotor constructed of a number of horse-shoe magnets, forming a polarised member, cylindrical in form.

Referring now to Fig. 1 the stator of the motor is cylindrical in form and is shown in section at A A with pole pieces

in the form of laminated rings of soft iron or similar high permeability material in the position indicated by the letters N S which letters also indicate the direction in which the stator is polarised. The inner edges of these pole pieces are toothed at *n* and *s* forming pole pieces and slots.

The rotor consists of a reel or bobbin B of soft iron whose cheeks C and D are similarly toothed at *c* and *d* forming pole pieces and slots of the same number as those in the stator. The teeth on the respective cheeks of the rotor bobbin are so placed as to be concentric with and opposite to the teeth formed in the respective stator ends.

The exciting winding W in the form of an annular coil is located between the cheeks C and D of the rotor B but is fixed to the stator construction so that it magnetises the rotor without rotating with it.

Thus most of the flux generated by the stator winding is available to act on the rotor and at each half-cycle a force is generated between stator and rotor. At a given instant all the poles on one rotor cheek may be of the same polarity as those on the adjacent stator resulting in a condition of magnetic instability and at another instant the polarity of that rotor cheek is reversed and stability is restored. Thus any given pole on the rotor cheeks will tend to move away from a like tooth on the adjacent stator during the moment of instability and similarly the same pole will tend to move towards an unlike tooth on the stator when stability is restored. An oscillating motion of half the distance between two adjacent stator teeth is thus produced. If now a starting impulse is given, the rotor pole will move progressively at one half-cycle from opposite the given stator tooth to opposite the adjacent polar gap and from the polar gap to the next adjacent tooth at the following half-cycle and a continuous rotary motion is produced.

The speed of the rotor therefore is expressed simply by the number of full cycles per second divided by the number of teeth in either rotor cheek.

Since in this my invention poles of opposite polarity are concentrated respectively in two separate annuli each and every pole of stator and rotor simultaneously co-act to produce a mechanical force and it follows that the dimensions of a motor constructed in accordance with this my invention are appreciably reduced.

A result of the construction as described is that if there are say 50 poles on each cheek of the rotor, and say 50 opposite poles on each side of the stator, a propelling force will be exercised at 50 points, equally spaced at each end of the motor, resulting in increased torque with efficiency and smooth balanced running, and economy in current consumption.

Referring now to Fig. 2 and 2A the stator is cylindrical in form but is constructed of a number of permanent bar magnets A on the ends of which are clamped similar pole pieces at N S toothed at *n s* forming teeth and slots, each end having like poles only. The rotor consists of a bobbin B with cheeks of soft iron C and D toothed at *c d* forming pole pieces of the same number as those in the stator to which they are opposite. The winding shown at W is effective upon the rotor but fixed to the stator.

Referring now to Fig. 3 the stator is provided in the form of a number of horse-shoe permanent magnets A forming a polarised member cylindrical in form, each end having like poles only, but in other respects the construction is similar to Figs. 1, 2 and 2A.

It is immaterial so far as this my invention is concerned which of the two members remains fixed and which rotates but the rotation of the external member is usually inconvenient from a constructional point of view therefore the types illustrated and described have the rotor in the centre and the exciting coil is designed to be completely clear of it though as close to it as possible so that the winding may be fixed and the bobbin left free to rotate.

It is also immaterial in this my invention which of the two elements is the axially polarised and which is of soft iron subject to the influence of the alternating current.

In the construction illustrated in Fig. 4 the stator is of soft iron and cylindrical in form. It is shown in section at A A with pole pieces toothed at *a a* forming poles with inter-polar gaps and the winding W embraces it. The rotor is constructed of permanent bar magnets N S arranged in cylindrical formation which letters also indicate the direction in which the rotor is polarised each end having like poles only. Pole pieces are provided at each end of the rotor with poles *n s* of the same number as the stator and with inter-polar spaces.

Fig. 5 illustrates a similar motor in which the stator winding W is almost completely embraced by soft iron A, whose inner edges are formed into pole pieces and slots. The rotor is constructed of an assemblage of horse-shoe permanent magnets N S arranged in cylindrical formation with pole pieces formed in the

manner previously described each end having like poles only.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An alternating current synchronous motor consisting of an unwound rotor, a stator and a fixed winding, in which either the rotor or the stator is formed of a single axially magnetised cylindrical element or of a group of polarised elements arranged in cylindrical formation about and magnetised in a direction parallel to the axis of rotation of the rotor.

2. A small alternating current synchronous motor as claimed in Claim 1, with a permanently magnetised stator cylindrical in form, magnetised in the direction of its axis, with annular pole pieces at each end and surrounding a rotor of soft iron provided with similar pole pieces and surrounded by a fixed coil, substantially as described with reference to Fig. 1 of the accompanying drawing.

3. An alternating current synchronous motor as claimed in Claim 1, with a stator consisting of a number of permanent bar magnets arranged in the form of a cylinder with like poles at the same end carrying annular pole pieces with teeth and slots at each end surrounding a rotor of soft iron with similar pole pieces adapted to revolve in the field of a fixed coil, substantially as described with reference to Figs. 2 and 2A of the accompanying drawing.

4. An alternating current synchronous motor as claimed in Claim 1 with a stator consisting of a number of permanent horse-shoe magnets assembled in the form of a cylinder, with like poles equidistant and opposite corresponding teeth and slots in the cheeks of a soft iron rotor adapted to revolve in the field of a fixed coil, substantially as described with reference to Fig. 3 of the accompanying drawing.

5. An alternating current motor as claimed in Claim 1, in which the stator consists of a ring of soft iron cylindrical in form, having an outer channel occupied by a fixed coil and inner edges at each end provided with teeth and slots and a rotor consisting of permanent magnets in cylindrical formation polarised in the direction of its axis with cheeks at each end provided with similar teeth and slots substantially as described with reference to Fig. 4 of the accompanying drawing.

6. An alternating current motor as claimed in Claim 1 in which the rotor consists of an assemblage of horse-shoe magnets in cylindrical formation polarised in the direction of the axis of rotation with pole pieces formed in the manner previously described with reference to Fig. 5 of the accompanying drawing.

Dated the 9th day of February, 1934.

F. HOPE-JONES.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1934.

FIG.1

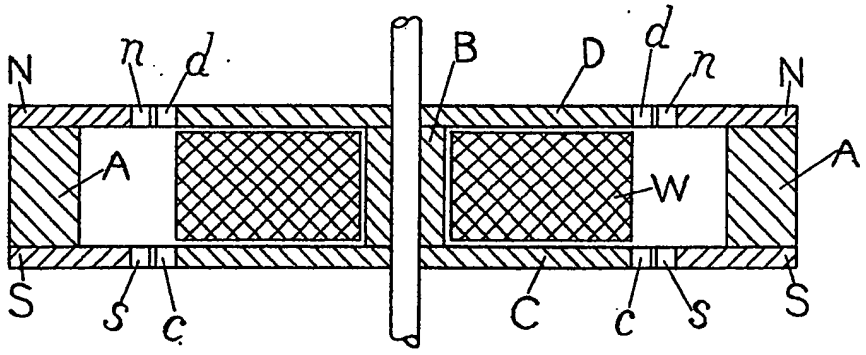


FIG.2

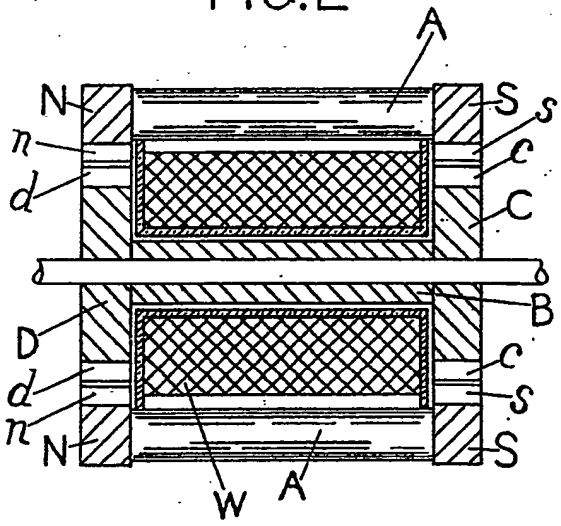


FIG.2A

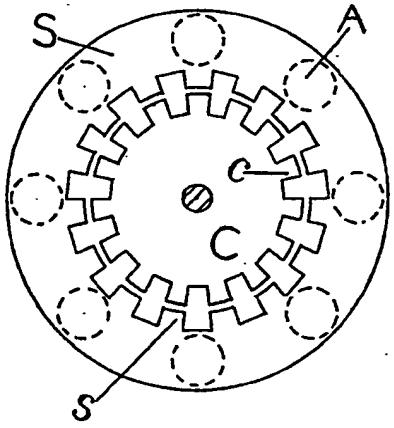
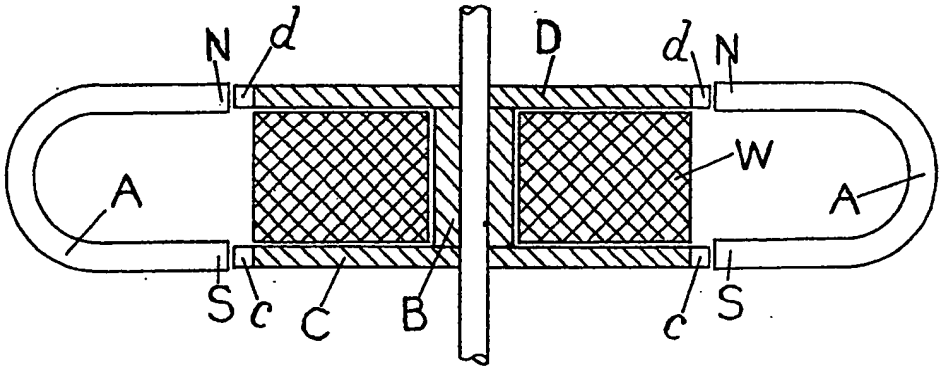
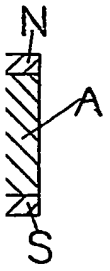


FIG.3



[This Drawing is a reproduction of the Original on a reduced scale.]



2A

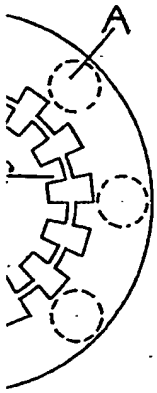


FIG. 4

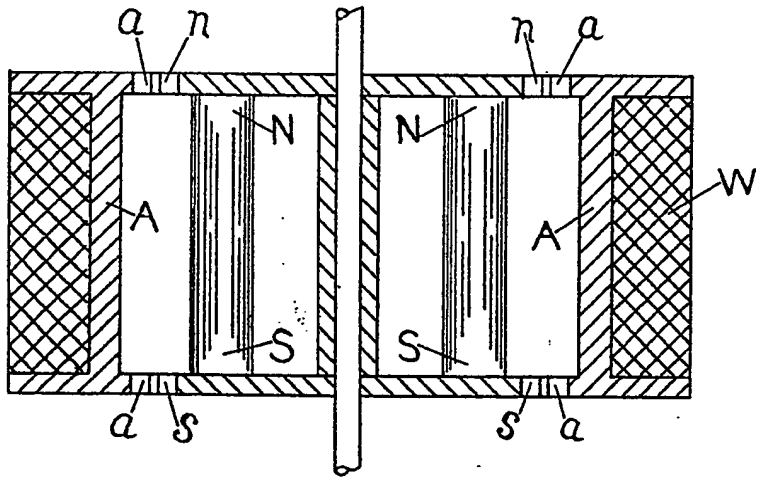


FIG. 5

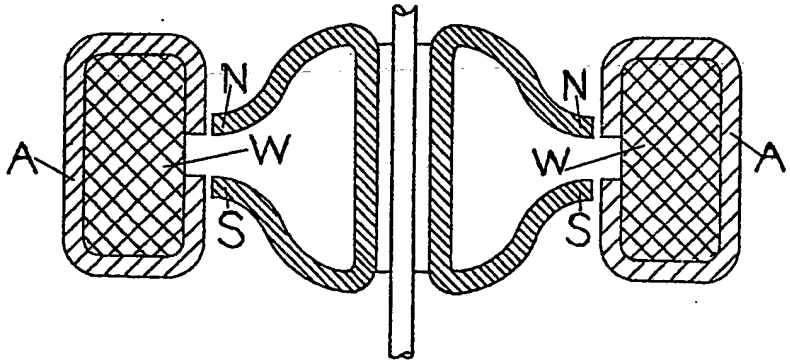


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FIG.1

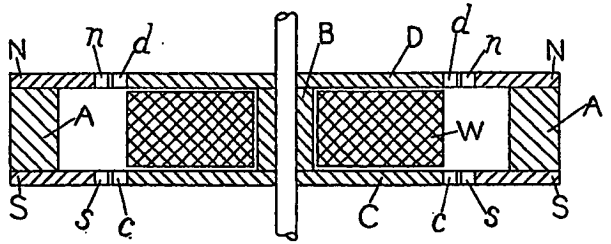


FIG.2

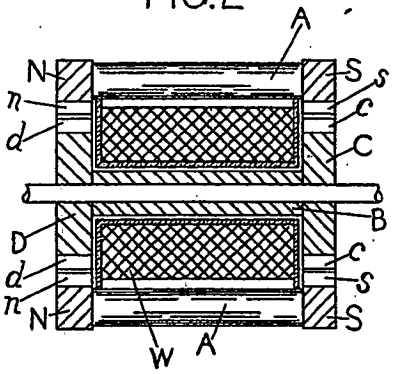


FIG.2A

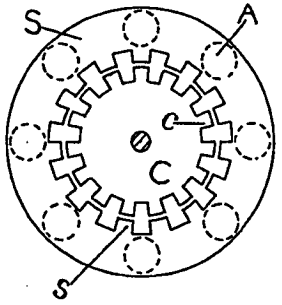


FIG.3

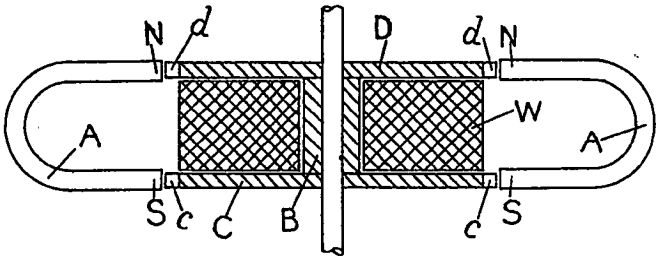


FIG.4

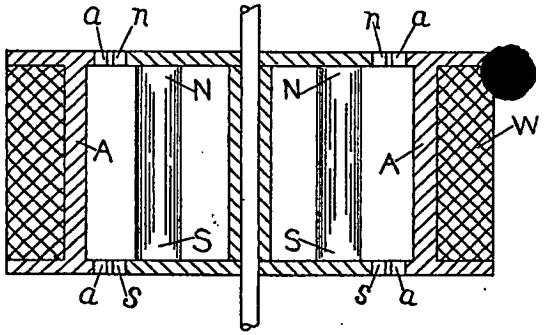
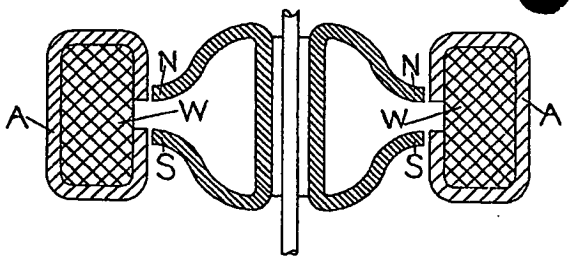


FIG.5



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